光喉石蝴蝶（苦苣苔科），云南植物一新种[*]

邱志敬[1,2]，李超群[2]，王印政[2**]

（1 深圳市中国科学院仙湖植物园，南亚热带植物多样性重点实验室，深圳　518004；
2 中国科学院植物研究所系统与进化植物学国家重点实验室，北京　100093）

摘要：报道了云南苦苣苔科植物一新种，即光喉石蝴蝶（*Petrocosmea glabristoma* Z. J. Qiu & Y. Z. Wang），并进行了详细描述和比较以及分子系统学证实。该新种在形态上和大理石蝴蝶（*P. forrestii* Craib）以及东川石蝴蝶（*P. mairei* Lévl.）相似，但叶片三角形或三角状卵形，花冠内面，尤其在喉部，光滑无毛，花丝显著较短明显区别于后者。

关键词：苦苣苔科；石蝴蝶属；新种；云南；中国

中图分类号：Q 949　　　　　　**文献标志码**：A　　　　　　**文章编号**：2095-0845（2015）05-551-06

Petrocosmea glabristoma（Gesneriaceae），a New Species from Yunnan，China

QIU Zhi-jing[1,2]，LI Chao-qun[2]，WANG Yin-zheng[2**]

（1 *Key Laboratory of Southern Subtropical Plant Diversity*，*Fairylake Botanical Garden*，*Shenzhen & Chinese Academy of Sciences*，Shenzhen 518004，China；2 *State Key Laboratory of Systematic and Evolutionary Botany*，*Institute of Botany*，*Chinese Academy of Sciences*，Beijing 100093，China）

Abstract：*Petrocosmea glabrstoma* Z. J. Qiu & Y. Z. Wang，a new species from Yunnan Province，China，is described and illustrated. The new species is similar to *Petrocosmea forrestii* Craib and *P. mairei* Lévl.，but differs from them mainly by its leaves triangular or triangular-ovate，corolla glabrous inside with shorter filament. Molecular and morphological data demonstrate that this new species has a close affinity to *P. forrestii*.

Key words：Gesneriaceae；*Petrocosmea*；New species；Yunnan；China

The genus *Petrocosmea* Oliver（Gesneriaceae，Cyrtandroideae，Didymocarpeae）was established in 1887 and presently consists of 38 species and 4 varieties（Oliver，1887；Wang，1985；Burtt，1998，2001；Li and Wang，2004；Wei and Wen，2009；Gou *et al.*，2010；Middleton and Triboun，2010；Zhao and Shui，2010；Shaw，2011；Xu *et al.*，2011；Qiu *et al.*，2011，2012；Zhang *et al.*，2013；Wang *et al.*，2013）. It was divided into three sec-tions，i. e. *Petrocosmea* Oliv.，*Anisochilus* Hemsl. and *Deinanthera* W. T. Wang by Wang in the second revision of *Petrocosmea*（Wang 1985；Wang *et al.*，1990，1998）. Plants of uncertain identity were found from Yunnan Province，China. These plants belong to sect. *Anisochilus* by the abaxial corolla lip two times longer than the adaxial and the anthers with no constriction. These plants are exceptional in the triangular or triangular-ovate leaves that are pubescent

on both surfaces and corolla glabrous inside, especially the adaxial corolla lip glabrous at throat, with two yellow spots on abaxial corolla lip at throat. These combined features of the newly collected plants differ from any reported species of *Petrocosmea*, but of a new species.

A molecular phylogenetic tree was also constructed base on chloroplast DNA regions of *trn*L-F, *mat*K, and *trn*T-L to ascertain the affinis of this new species.

1 Material and methods

In the phylogenetic analysis, we sampled three species of Sect. *Petrocosmea*, eight species or variety of Sect. *Anisochilus*, and three species of Sect. *Deinanthera*. *Raphiocarpus begoniifolius* Burtt and *R. petelotii* (Pellegr.) Burtt are chosen as outgroups for the phylogenetic analysis. The voucher information of all sampled taxa and GenBank accession numbers are listed in Table 1.

Total DNA was extracted from silica-gel-dried and fresh leaf materials using the CTAB method (Rogers and Bendich, 1988) and used as the templates in the polymerase chain reaction (PCR). The

primers used for amplification were c and f for the chloroplast intergenic region *trn*L-F, a and b (Taberlet *et al.*, 1991) for chloroplast *trn*T-L, and *mat*K-AF and *trn*K-2R (Johnson and Soltis, 1994; Ooi *et al.*, 1995) for chloroplast *mat*K gene. PCR was conducted under the following conditions: 95 ℃ for 4 min; 30 cycles of 94 ℃ for 30 s, 56 ℃ for 30 s, 72 ℃ for 1 min; and a final extension at 72 ℃ for 10 min. The PCR products were purified using Tian quick Midi Purification Kit (Tiangen Biotech, Beijing, China) following the manufacture's protocol and were directly sequenced. The sequencing primers are the same as amplification primers except *mat*K region. In the *mat*K region sequencing, a reverse primer of matK-8R (Ooi *et al.*, 1995) was added.

All of the sequences were aligned using Clustal X1.83 (Thompson *et al.*, 1997) and adjusted manually using BioEdit5.0.9 (Hall, 1999). The DNA data were analyzed with maximum parsimony (MP), implemented in PAUP*4.0b10 (Swofford, 2003), and Bayesian inference (BI), implemented in Mrbayes version 3.0b4 (Ronquist and Huelsenbeck, 2003), methods.

In MP analysis, character states were unordered

Table 1　Species, voucher with collection locality and GenBank accession number for taxa included in this study

Taxon	Voucher, Collection Locality and Citation	GenBank Accession Number		
		*trn*L-F	*mat*K	*trn*T-L
Petrocosmea grandifolia W. T. Wang	QZJ-2007-037, Yunnan, China (PE)	JN092472	JN092541	JN092505
P. kerrii Craib	04603, Yunnan, China (KUN)	JN092474	JN092543	JN092507
P. minor Hemsl.	QZJ-2008-54, Yunnan, China (PE)	JN092478	JN092547	JN092511
P. oblata Craib	Q060923-1, Sichuan, China (PE)	GU350692	JN092549	JN092513
P. sericea C. Y. Wu ex H. W. Li	991104, Yunnan, China (KUN)	JN092467	JN092536	JN092500
P. sinensis Oliver	QZJ-2008-41, Sichuan, China (PE)	GU350691	JN092550	JN092514
P. duclouxii Craib	Q06100101, Yunnan, China (PE)	JX142177	JX142174	JX142180
P. hexiensis S. Z. Zhang & Z. Y. Liu	Z. Y. Liu 110128, Chongqing, China (SZG)	JX142179	JX142176	JX142182
P. barbata Craib	QZJ-2007-009, Yunnan, China (PE)	KR006351	KR006438	KR006424
P. cavaleriei H. Lévl.	QZJ-2007-082, Guizhou, China (PE)	KR006372	KR006440	KR006420
P. forrestii Craib	QZJ-2008-58, Yunnan, China (PE)	KR006365	KR006445	KR006416
P. mairei H. Lévl.	019140, Yunnan, China (KUN)	KR006366	KR006447	KR006418
P. glabristoma Z. J. Qiu & Y. Z. Wang	QZJ-2007-061, Yunnan, China (PE)	KR006362	KR006444	KR006417
Outgroups				
Raphiocarpus begoniifolius (Lévl) Burtt	QZJ-2008-026, Guizhou, China (PE)	GU350680	JN092551	JN092515
R. petelotii (Pellegr) Burtt	GX_NP_1, Guangxi, China (PE)	JN092480	JN092552	JN092516

and all characters were given equal weights. Heuristic searches were performed with 1 000 replicates of random addition，with the default setting of one tree held at each step during stepwise addition，tree-bisection-reconnection（TBR）branch swapping，Multrees in effect，and steepest descent off. Bootstrap support（Felsenstein，1985）for each clade was estimated from 1 000 heuristic search replicates following the setting described above.

For BI analysis，four chains of the Markov Chain Monte Carlo were run each for 10 000 000 generations and were sampled every 10 000 generations. For each run，the first 200 samples were discarded as burn-in，which can make sure that the chains reached stationary. Posterior probability（PP）was used to estimate robustness in the majority rule consensus from Bayesian analysis.

2　Results and discussion

The combined cpDNA matrix with three chloroplast regions of *mat*K，*trn*L-F and *trn*T-L had aligned sequences of 3 076 bp，of which 73（2. 37%）were parsimony informative. The strict consensus of the six trees yielded by maximum parsimony（MP）analysis（L = 210，CI = 0. 967，RI = 0. 941）was congruent with the majority rule consensus Bayesian tree in the topology（Fig. 1）.

In the molecular phylogenetic tree，the new species *P. glabristoma* sp. nov. is sister to *P. forrestii* Craib with supports of BS = 51% and PP = 77%，and together they are grouped with *P. mairei* Lévl.（BS = 87% and PP = 100%）. This branch is further joined together with another strongly supported branch consisting of *P. barbata* Craib and *P. cavaleriei* Lévl.（BS = 97%，PP = 100%）.

As mentioned above，this new species *P. glabristoma* is grouped together with *P. forrestii*，*P. mairei*，*P. babata* and *P. cavaleriei* in a clade in the molecular phylogenetic tree. Accordingly，they share a series of synapomorphies in morphology. These combined synapomorphies are the abaxial corolla lip two times longer than the adaxial lip，adaxial corolla lip

densely villose inside at throat（except for this new species），two bright yellow spots or cicatrices on the abaxial lip at the throat of corolla tube and the adaxial lip usually extended forward or upward rather than reflexed strongly backward. This new species especially has a close affinity to *P. forrestii* in morphology of adaxial corolla lobes oblate and ovary pubescent with style slightly bending upward at tip. However，the new species can be easily recognized by its leaves triangular or ovate-triangular，corolla glabrous inside，especially the adaxial corolla lip at throat，adaxial corolla lobes extended upward with shorter filaments（1–1. 3 mm long）. With respect to these morphological characters，*P. forrestii* is featured by leaves rhombic or narrowly ovate with truncate bases，adaxial corolla lip densely villose inside at throat with lobes extended forward and longer filaments（about 2 mm long）. The new species is also similar to *P. mairei*，however，they are also easily to be distinguished from each other by the oblong or narrowly ovate leaves，corolla throat and tube wholly
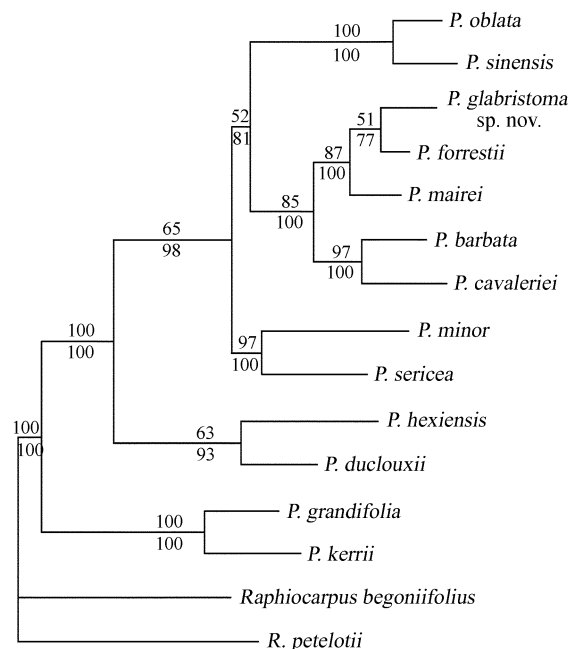

Fig. 1　One of six most parsimonious trees generated from analysis of combined DNA of *mat*K，*trn*L-F and *trn*T-L. Branch lengths are proportional to numbers of nucleotide substitutions（scales represent 1 substitution）. Above the branches are MP bootstrap（MP-BS）values，below the branches are Bayesian posterior probabilities（PP）

densely villose inside, adaxial corolla lobes elliptic and extended forward with longer filaments (about 2 mm long) in the latter.

The new species of *P. glabristoma* is now known from three localities respectively in Jinggu County and Mengla County, south of Yunnan Province. *P. forrestii* has a wide geographic distribution in the west and central region of Yunnan Province. And *P. mairei* is distributed only in Dongchuan City, Yunnan Province. There is no overlap of geographic distribution among these three species.

3　Taxonomic treatments

Petrocosmea glabristoma Z. J. Qiu & Y. Z. Wang sp. nov.

Type: China. Yunnan Province: Jinggu County, Jinglin Bridge, alt. 780 m, Sep. 18, 2007. Z. J. Qiu QZJ-2007-061 (holotype, PE); alt. 850 m, Oct. 10, 2013, Z. J. Qiu QZJ-0718 (paratype, SZG); Mengla County, Menglun Town, Cuiping hill, alt. 830 m, Sep. 21, 2013, Y. Dong & C-Q Li, DL-201309-0021 (paratype, PE). Fig. 2–3.

Diagnose: The new species is similar to *P. forrestii* in adaxial corolla lobes oblate and ovary pubescent with style slightly bending upward at tip, but differs from the latter mainly in its leaves triangular or ovate-triangular, corolla glabrous inside at throat, adaxial corolla lobes extended upward with shorter filaments.

Perennial herb, rosettes, with short rhizome and crowded fibrous roots. Leaves 10 to 30, all basal, crowded, the inner leaves with petioles short or absent, the outer leaves with longer petioles; leaves triangular or triangular-ovate, 0.5–3.5 × 0.5–3 cm, herbaceous, apex round, base truncate, cuneiform or nearly cordate, margin entire, both surfaces with densely pubescence, lateral veins 3–4 on each side, not distinct; petioles 0.3–6 cm long, densely pilose. Cymes 3 to 10, 1–3 flowers per cyma; peduncle 5–15 cm long, densely pilose; bracts 2 at mid-peduncle, lanceolate, 0.5–1.2 cm long, pubescent, pedicel 1.5–5 cm long, densely hairy; sepals 5-divided

to the base, narrowly lanceolate, ca. 4–5 mm long, pubescent externally. Corolla light-blue to white, puberulent outside, glabrous inside, two yellow spots on abaxial corolla lip at throat; tube ca. 3 mm, adaxial lip ca. 5.5–6 mm long, bi-lobed near to base, lobes oblate, abaxial lip ca. 10–12 mm long, tri-lobed to the middle, lateral lobes oblong, ventral lobe nearly circular; stamens 2, ca. 3.5 mm long; filaments adnate to ca. 1 mm above base of corolla tube, 1–1.3 mm long, glabrous; anthers oblique-ovate, ca. 2 mm long, glabrous; staminodes 3, adnate to 0.2–0.4 mm above base of corolla tube, 0.2–0.5 mm long, glabrous; pistil ca. 9 mm long; ovary pubescent, ovoid, oblique abaxially, ca. 2 mm long; style glabrous or sparsely pubescent at base, ca. 7 mm long, slightly bending upward at tip.

Phenology: The new species was observed to flower from August to October; fruits not seen.

Habitat and distribution: *Petrocosmea glabristoma* grows on moist shady cliffs of limestone hill,
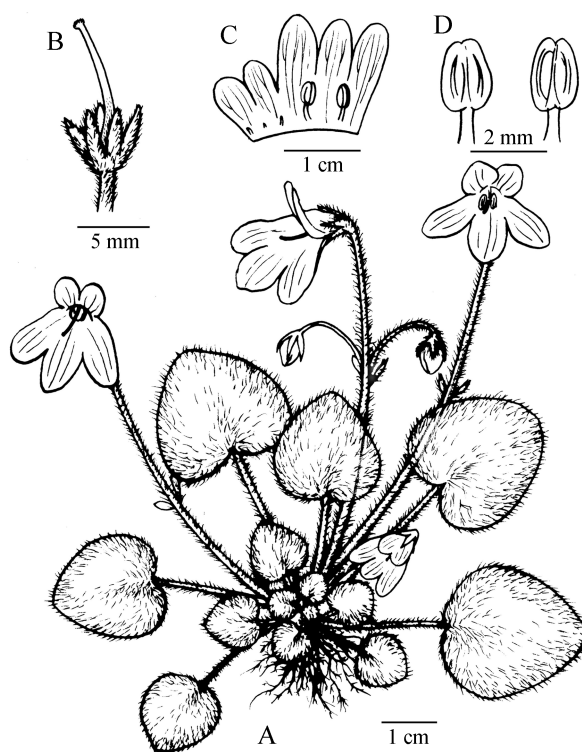

Fig. 2　Drawing of *Petrocosmea glabristoma* Z. J. Qiu & Y. Z. Wang. A, Habit; B, Calyx and pistil; C, Dissected corolla; D, Stamens. Drawn from the holotype Z. J. Qiu QZJ-2007-061 (PE) by Z. J. Qiu and A. L. Li

Fig. 3　Photos of *Petrocosmea glabristoma* with comparison of *P. forrestii*. 1－6，*P. glabristoma*，1，Habitat，growing on the moist shady cliff of the limestone hill，scale bar＝7.62 cm；2，Plant with basal leaves，scale bar＝1.81 cm；3－4，Flower of front view，showing pistil and anthers，and adaxial corolla lip glabrous at throat inside（4），scale bar＝0.62 cm in 3，0.61 cm in 4；5，Flower of side view，scale bar＝0.59 cm；6，Stamen，scale bar＝0.1 cm. 7－11，*P. forrestii*，7，Stamen，scale bar＝0.1 cm；8，Plant with basal leaves，scale bar＝3.03 cm；9－10，Flower of front view，showing adaxial corolla lip densely villose at throat inside（10），scale bar＝0.43 cm in 9，0.38 cm in 10；11，Flower of side view，scale bar＝0.48 cm

at 780－850 m altitude，in Yunnan Province，Southwestern China. In the three localities，two localities respectively containing about 1 000 and 200 individuals were found in Jinglin Bridge，Jinggu County. The two localities are connected by a provincial road. The third locality with about 200 individuals was found in Cuiping hill，Menglun Town，Mengla County.

tute of Botany, CAS) for the useful suggestions and Li Ai-Li
for her excellent drawing.

References：

Burtt BL, 1998. A new species of *Petrocosmea* ［J］. *The Gloxinian*,
(1)：14—15

Burtt BL, 2001. Flora of Thailand：Annotated Checklist of Gesneri-
aceae ［J］. *Thai Forest Bulletin (Botany)*, **Vol. 29**：105—106

Felsenstein J, 1985. Confidence-limits on phylogenies：An approach
using the bootstrap ［J］. *Evolution*, **39**：783—791

Gou GQ, Wang XY, Xiong YX, 2010. *Petrocosmea xanthomaculata*
G. Q. Gou et A. Y. Wang, a new species of the genus *Petrocosmea*
Oliv. ［J］. *Bulletin of Botanical Research*, **30** (4)：394—396

Hall TA, 1999. BioEdit：A user-friendly biological sequence align-
ment editor and analysis program for Windows 95/98/NT ［J］.
Nucleic Acids Symposium Series, **41**：95—98

Johnson LA, Soltis DE, 1994. *Mat*K DNA-sequences and phylogenet-
ic reconstruction in Saxifragaceae s-str ［J］. *Systematic Botany*,
19 (1)：143—156

Li ZY, Wang YZ, 2004. *Petrocosmea* Oliver. ［A］// *Plants of Gesne-
riaceae in China* ［M］. Zhengzhou：Henan Science & Technology
Publishing House, 154—166

Middleton DJ, Triboun P, 2010. Two new species of Petrocosmea
(Gesneriaceae) from Thailand ［J］. *Thai Forest Bulletin (Bota-
ny)*, **38**：42—47

Oliver D, 1887. *Petrocosmea sinensis* Oliv. ［J］. *Hook. Icon. Pl*, **18**：
pl. 1716

Ooi K, Endo Y, Yokoyama J *et al.*, 1995. Useful primer designs to
amplify DNA fragments of the plastid gene *mat*K from angiosperm
plants ［J］. *Japanese Journal of Botany*, **70** (6)：328—331

Qiu ZJ, Yuan ZL, Li ZY *et al.*, 2011. Confirmation of a natural hy-
brid species in *Petrocosmea* (Gesneriaceae) based on molecular
and morphological evidence ［J］. *Journal of Systematics and Evo-
lution*, **49** (5)：449—463

Qiu ZJ, Wang XL, Liu ZY *et al.*, 2012. The cytological and phyloge-
netic study of *Petrocosmea hexiensis* (Gesneriaceae), a new spe-
cies from Chongqing, China ［J］. *Phytotaxa*, **74**：30—38

Rogers SO, Bendich AJ, 1988. Extraction of DNA from plant tissues
［J］. *Plant Molecular Biology Manual*, **A6**：1—10

Ronquist F, Huelsenbeck JP, 2003. MrBayes 3：Bayesian phyloge-
netic inference under mixed models ［J］. *Bioinformatics*, **19**：
1572—1574

Shaw J, 2011. A new species of *Petrocosmea* ［J］. *The Plantsman*, **10**
(September)：177—179

Swofford DL, 2003. *PAUP* *：*Phylogenetic Analysis Using Parsimony
(and other methods)* ［M］. V. 4. 0 beta 10. Sunderland, Sinauer
Associates

Taberlet P, Gielly L, Pautou G *et al.*, 1991. Universal primer for am-
plification of three non-coding regions of chloroplast DNA ［J］.
Plant Molecular Biology, **17**：1105—1109

Thompson JD, Gibson TJ, Plewniak F *et al.*, 1997. The Clustal X
windows interface flexible strategies for multiple sequence align-
ment aided by quality analysis tools ［J］. *Nucleic Acids Re-
search*, **24**：4876—4882

Wang HC, Zhang LB, He ZR, 2013. *Petrocosmea melanophthalma*, a
New Species in Section *Deianthera* (Gesneriaceae) from Yun-
nan, China ［J］. *Novon*, **22** (4)：486—490

Wang WT, 1985. The Second Revision of the Genus *Petrocosmea*
［J］. *Acta Botanica Yunnanica*, **7** (1)：49—68

Wang WT, Pan KY, Li ZY, 1990. *Petrocosmea* ［A］// Wang WT
ed., *Flora Republicae Popularis Sinicae*, Vol. 69 ［M］. Bei-
jing：Science Press, 329—331

Wang WT, Pan KY, Li ZY, 1998. *Petrocosmea* ［A］// Wu ZY, Ra-
ven PH eds., *Flora of China*, Vol. 18 (Scrophulariaceae
through Gesneriaceae) ［M］. Beijing：Science Press；St. Lou-
is：Missouri Botanical Garden Press, 302—308

Wei YG, Wen F, 2009. *Petrocosmea xingyiensis* (Gesneriaceae), a
new species from Guizhou, China ［J］. *Novon*, **19** (2)：261—
262

Xu WB, Pan B, Liu Y, 2011. *Petrocosmea huanjiangensis*, a new
species of Gesneriaceae from limestone areas in Guangxi, China
［J］. *Novon*, **21**：385—387

Zhao HT, Shui YM, 2010. *Petrocosmea shilinensis*, a new species of
Gesneriaceae from Yunnan, China ［J］. *Acta Botanica Yunnani-
ca*, **32** (4)：328—330

Zhang Q, Pan B, Meng T *et al.*, 2013. *Petrocosmea funingensis*
(Gesneriaceae)：a new species from southeastern Yunnan, Chi-
na ［J］. *Phytotaxa*, **77** (1)：5—8